ATM Preliminary Design Process and Future Operational Concept Evaluation

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Outline

DAG-ish Preamble

AATT SDI CTO-2 Statement of Objectives

Preliminary Design Process Methodology

- process goals and requirements
- proposed PD process
- ATM system functions, agents and resources
- AATT technology and system functions
- DAG-TM concept elements and system functions
- proposed analysis toolset architecture

PD Phase 1 Contract with NASA/Volpe/NEXTOR

- Chicago area selected as a case study airspace

PD Process and DAG-TM CE-11

DAG-ish Preamble

Boeing participated in Task Force 3 (Taylor, Schwab)

- strong airline and avionics push
- vague report language to accommodate all stakeholders
- no supporting business case, only a notion of annual (1995) cost of traffic “inefficiencies”

How can Boeing help the airlines and the flying public?

- single-airplane path efficiency can’t pay for CNS/ATM-1 avionics
- the cost is in the avionics certification requirements
- maybe the “gridlock” problem can make the business case
- Boeing will benefit from accomodating traffic growth

CNS/ATM-1 => far-term => DAG-TM

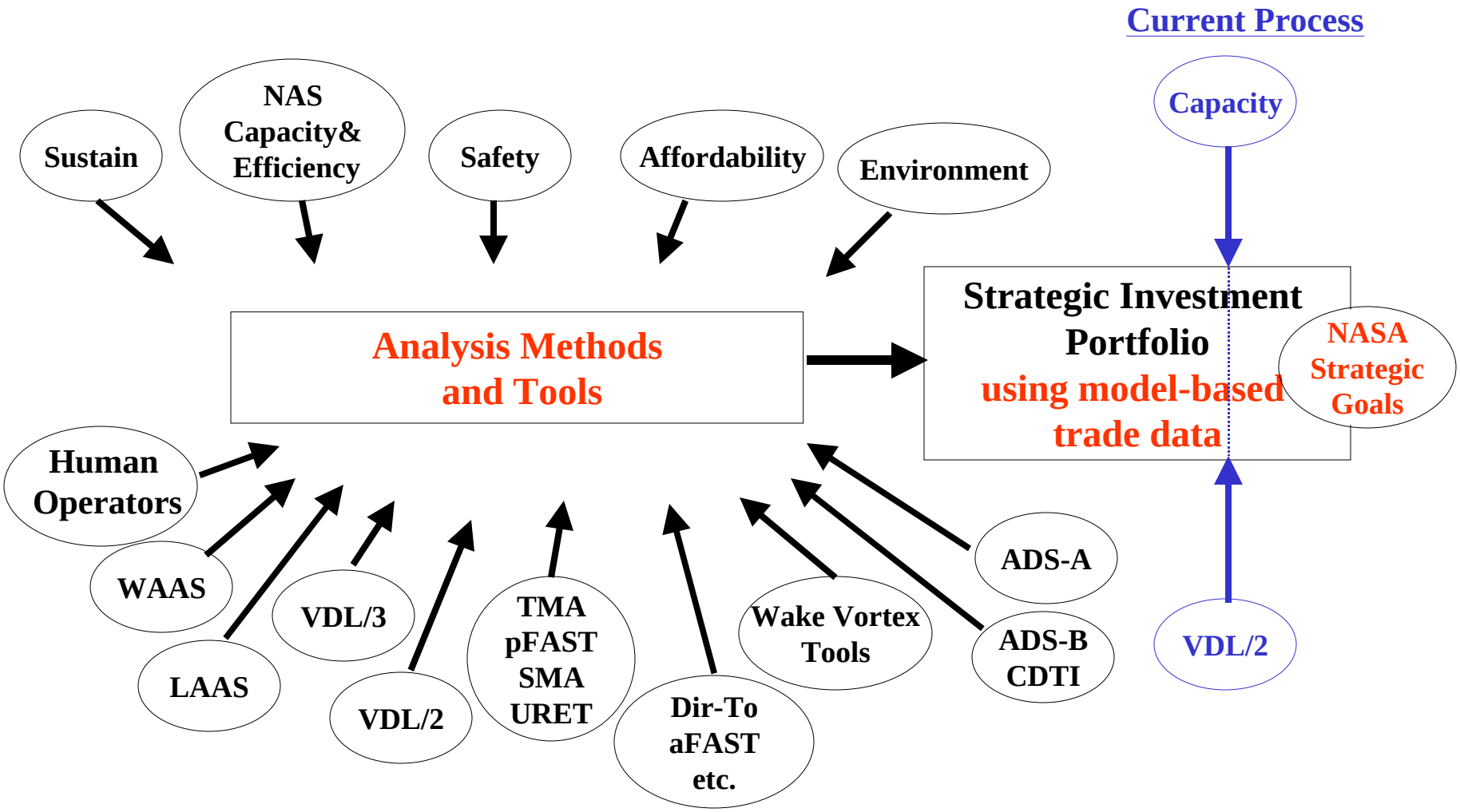
We still have to

- certify the equipment
- make the business case
- this requires taking research concepts into “preliminary design”

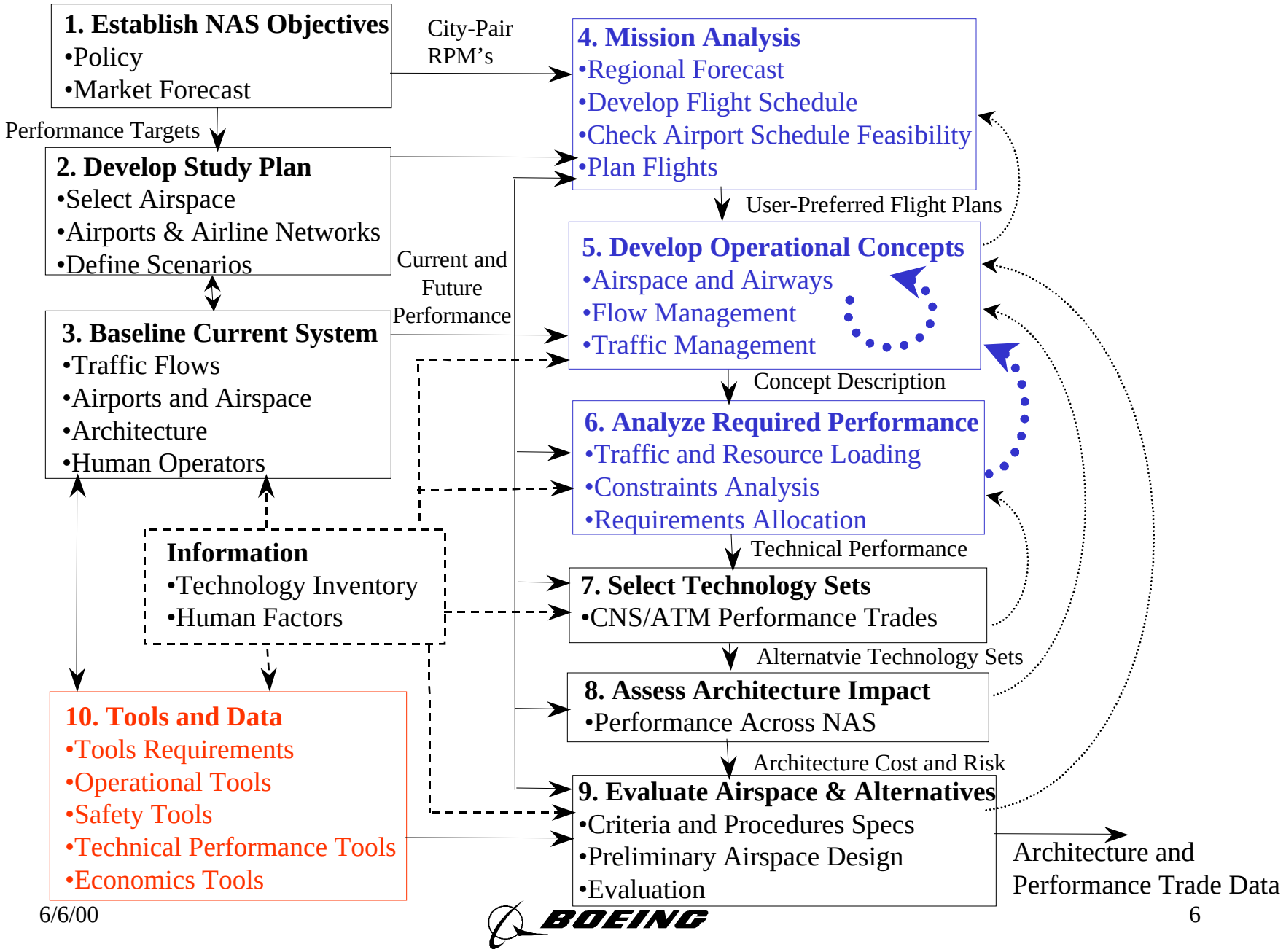
AATT SDI CTO-2 Statement of Objectives

- "The DAG TM team requires a modeling, simulation, and analysis capability in order to assess the performance and economic benefits enabled by the various concept elements such that this information can, one, be added to the decision process when selecting amongst "competing" concept elements, and two, assess the overall impact of a DAG TM environment."
- This is the long, skinny bubble at the bottom of all the DAG-TM planning charts
- What makes it different from the other bubbles?
  - they all use human-in-the-loop evaluations: part-task, high-fidelity, flight test
  - we are talking about analytical and fast-time simulation methods
  - we believe such methods can also directly support concept exploration
  - cheaper to use => enables broader concept trades

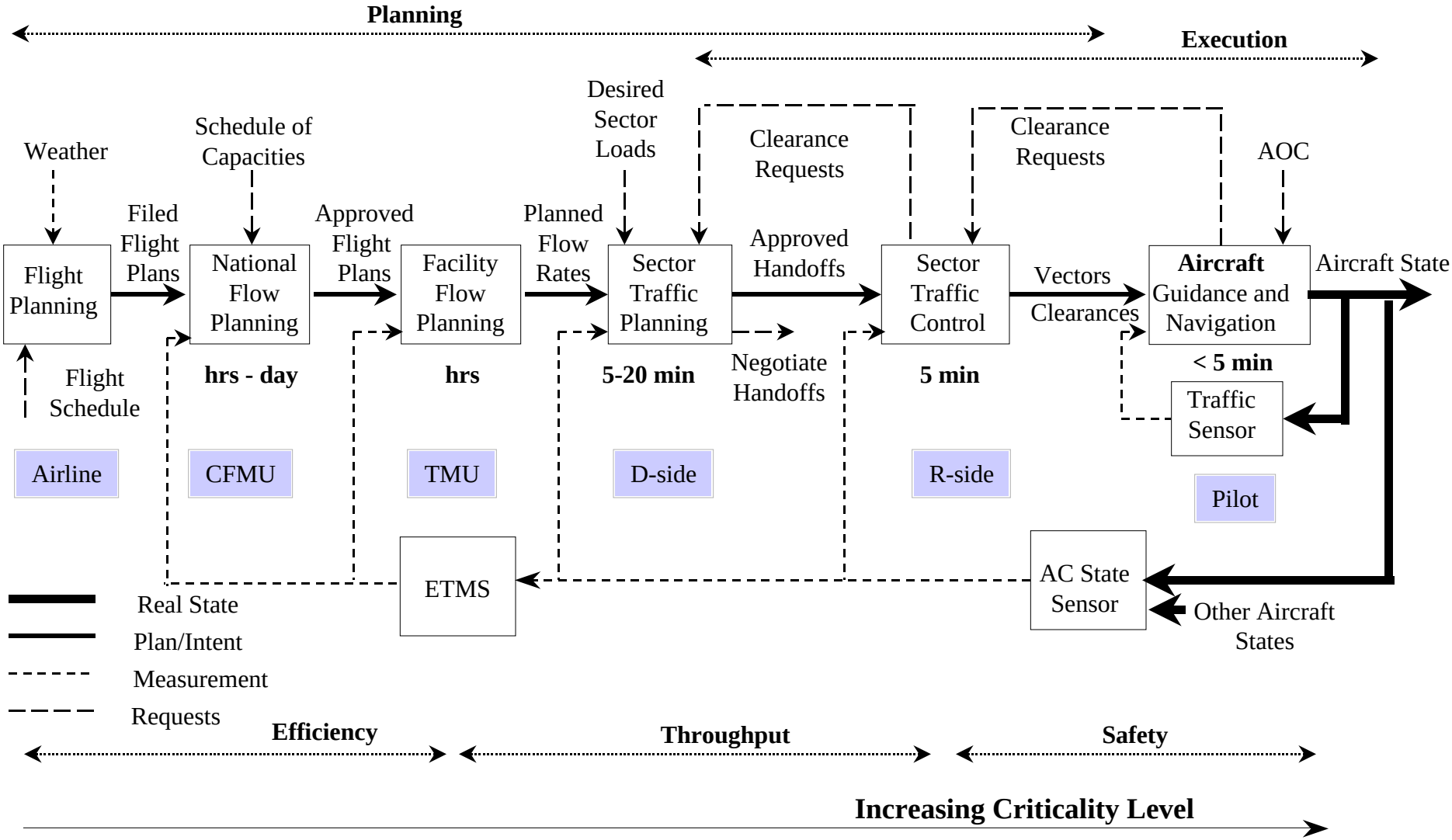
CNS/ATM Strategic Investment Analysis Problem



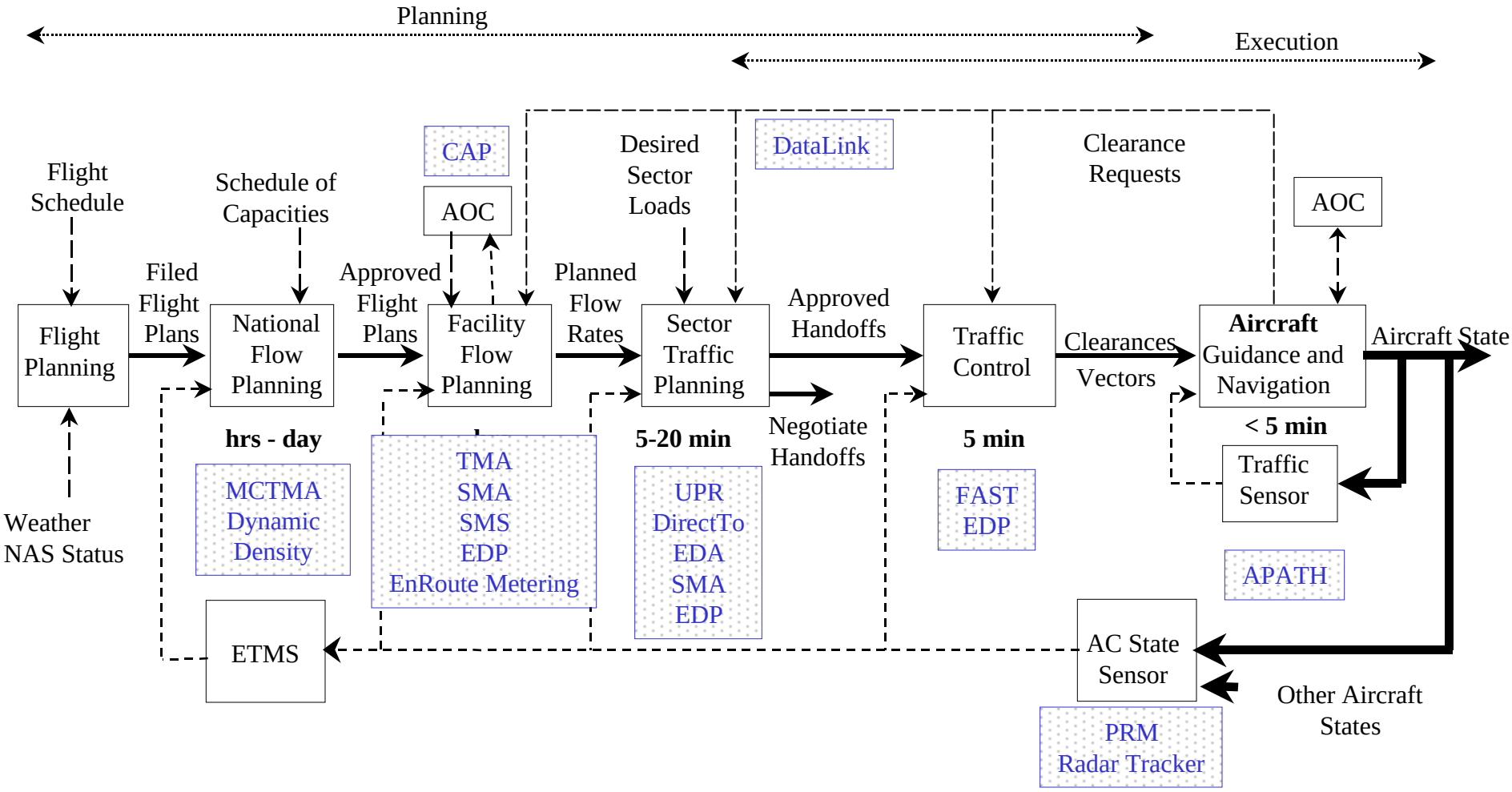
NAS Preliminary Design Process



ATM System Functional Structure



AATT Technologies and ATM Functions



List of DAG-TM Concept Elements

Over-arching

Gate-to-Gate:
- CE-0 Data Exchange

Pre-flight

Pre-flight Planning:
- CE-1 User optimization for Constraints

Flight Operations

Surface Departure:
- CE-2 Intelligent [Taxi] routing

Terminal Departure:
- CE-3 Free Maneuvering for Separation
- CE-4 Trajectory Negotiation for Separation

En route: (Separation and local-TFM Conformance)
- CE-5 (a/b) Free Maneuvering
- CE-6 (a/b) Trajectory Negotiation

En route: (local-TFM)
- CE-7 Collaboration for SUA/Wx/Complexity

En route / Terminal: (local-TFM)
- CE-8 Collaboration for Arrival Metering

Terminal Arrival:
- CE-9 Free Maneuvering Around Weather
- CE-10 Trajectory Up link [to avoid] Weather

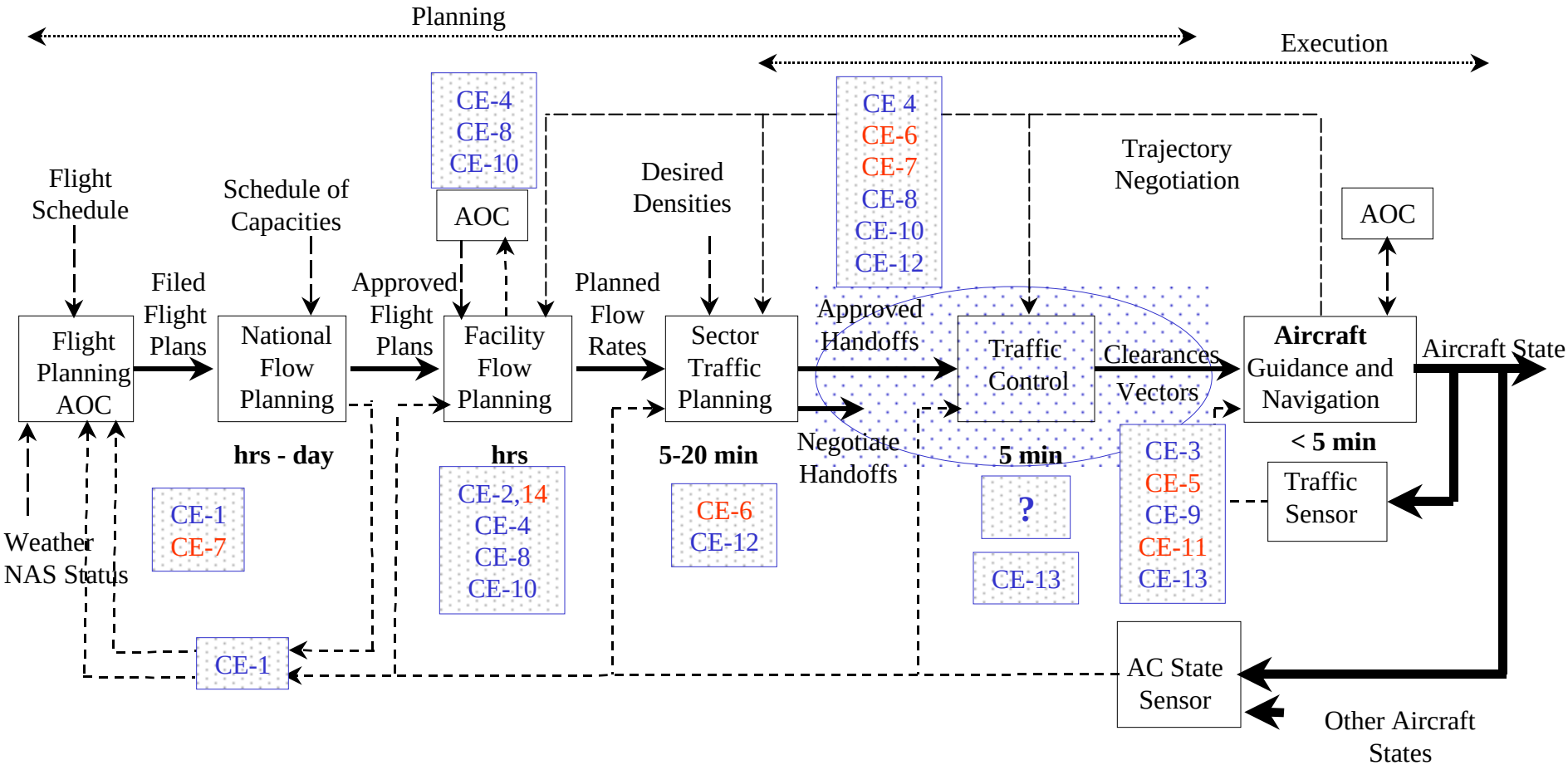
Terminal Arrival:
- CE-11 Self Spacing for Accurate Merge
- CE-12 Trajectory Exchange for Accurate Merge

Terminal Approach:
- CE-13 Closely Spaced Approaches

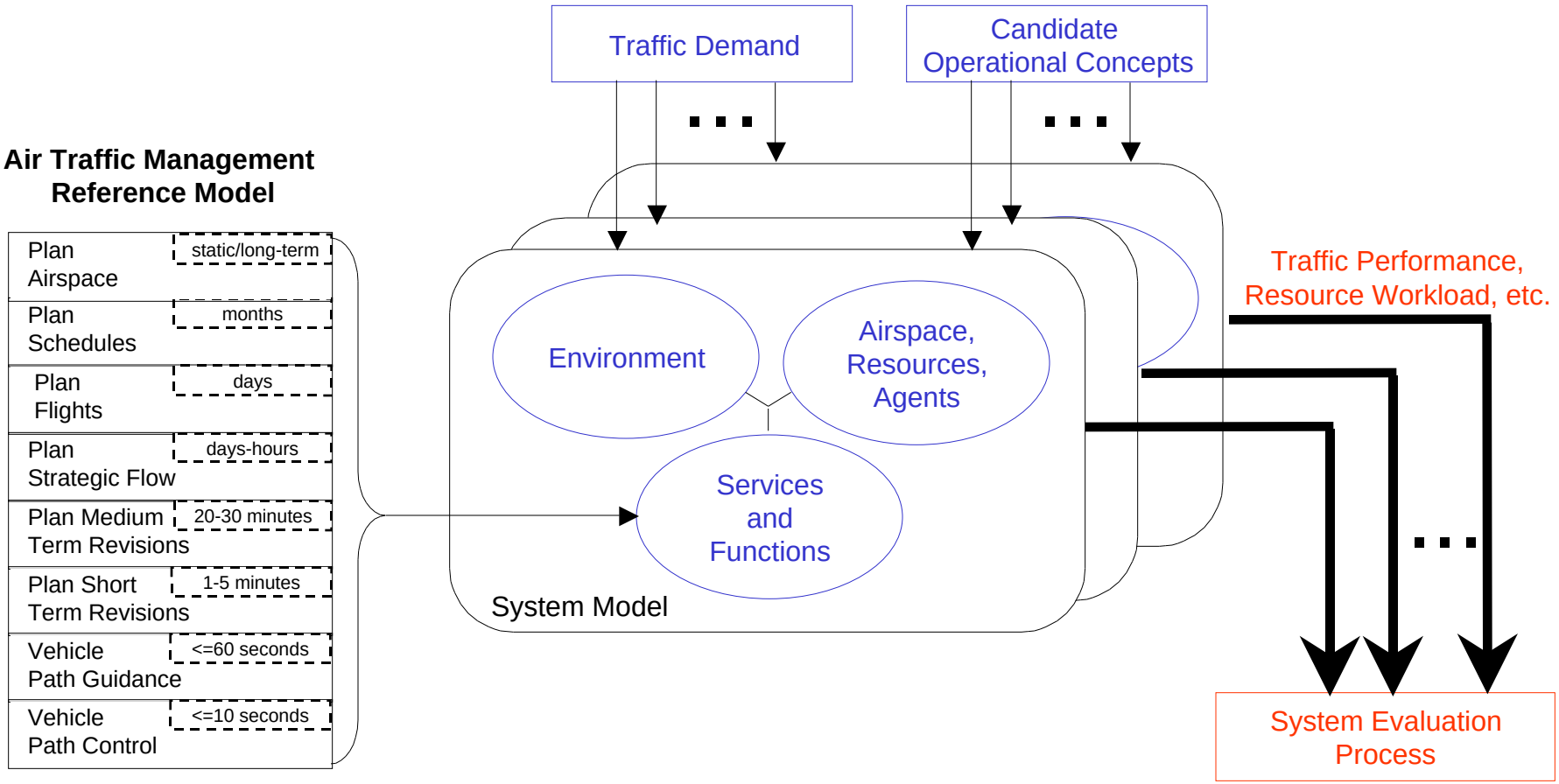
Surface Arrival:
- CE-14 Intelligent [Taxi] Routing

TFM = Traffic Flow Management

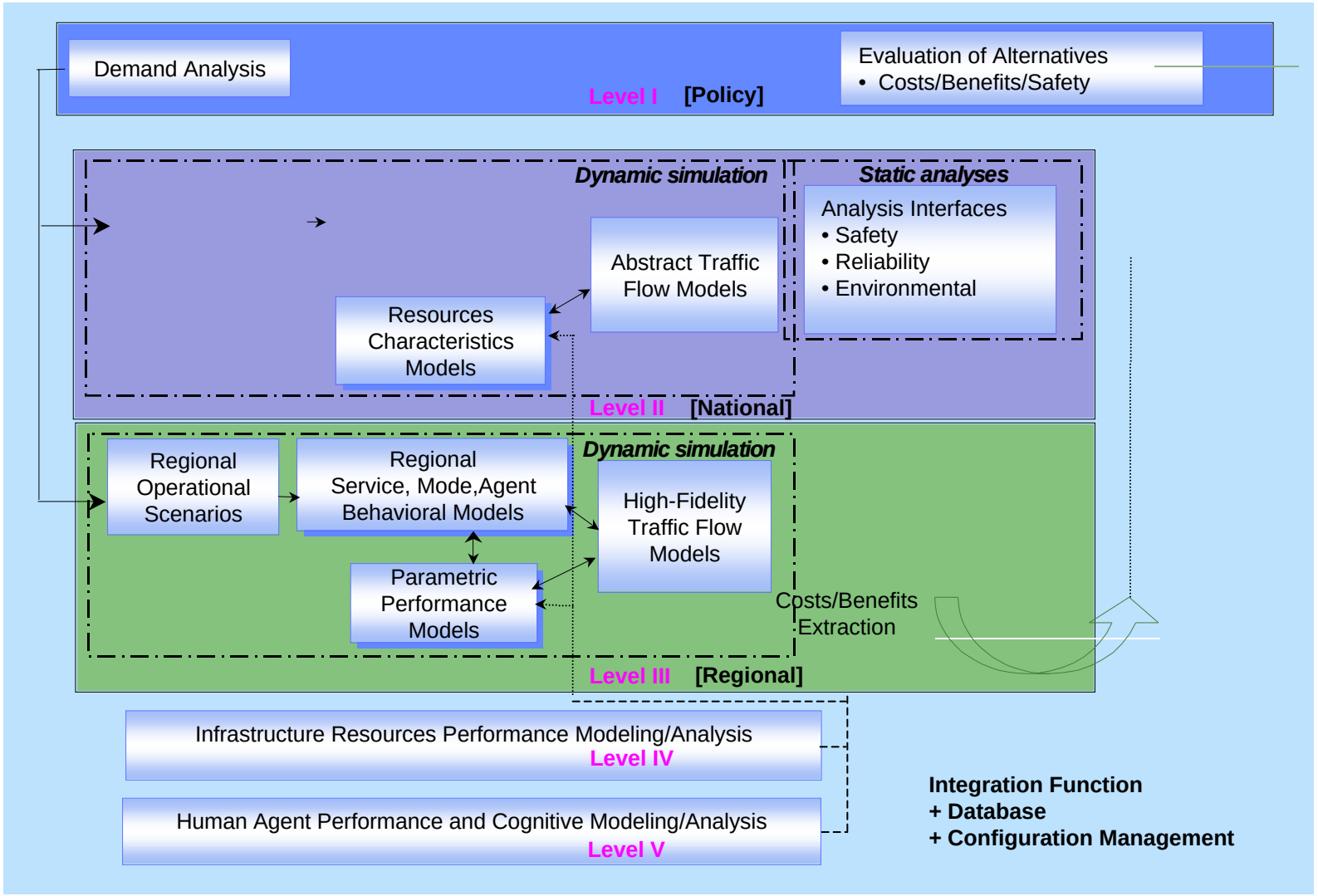
DAG-TM Concept Elements and ATM Functions



ATM Modeling Methodology



Notional PD Toolset Architecture



PD Methodology Summary

- There is currently inadequate trade data available to support decisions influencing the NAS long-term architecture
- Credible CNS/ATM investment analysis requires clear relationships between human, technology and traffic performance
- The current fast-time analysis toolset is not suited for preliminary-design analysis of medium and long-term operational concepts
- Further development of human performance models, computationally feasible with a detailed traffic flow simulation, is needed for effective concept exploration
- Coordinated normal, rare-normal and non-normal evaluation of concepts and technology is needed to assess cost and benefits

Preliminary Design Process, Phase 1

Project sponsored by the NASA AATT program (S. Hasan) and the FAA

Project team:

- Boeing Commercial Airplane Group
- Volpe Transportation Center
- Logistics Management Institute (LMI)
- Kevin Corker, San Jose State University
- Flight Transportation Associates (FTA, Simpson)
- NEXTOR (Hansman)

Objective and approach:

- To establish a modeling and analysis capability to support preliminary design for the long-term NAS
- The Chicago area was selected as a case study airspace

The current Phase 1 will

- develop a baselining framework to drive tools and data requirements
- identify operational needs and developt initial directions for concept and technology solutions

PD Phase 1 and Beyond

- Chicago is the initial Case Study airport/airspace region
  - some operational issues are specific, others are common to high-density complex terminal areas
- Additional Case Study regions to address overall NAS performance
  - comprehensive concept and technology exploration
  - sufficient scope to develop toolset requirements for NAS-wide trades
- Design and implementation of an integrated PD toolset
  - effective concept exploration across the range of DAG-TM concept variables, connecting human and technology performance to traffic performance
  - provide real trade data to establish industry investment direction

PD Process and DAG-TM CE-11

Back to the “gridlock” problem, i.e. system capacity

- complex, high-density terminal area appears to present the primary airspace bottleneck(s)

CE-11 addresses one of those, i.e. final approach spacing buffers

Performance trade studies on final approach spacing concepts

- ATC vectors
  - current with VHF voice
  - with TMA, with pFAST, with aFAST
  - with data link
- Aircraft executes trajectory plan
  - generated by a TMA-type ground function
  - RTA’s at selected points
  - daisy-chain for relative spacing
  - manual or autopilot (human vs. automation)